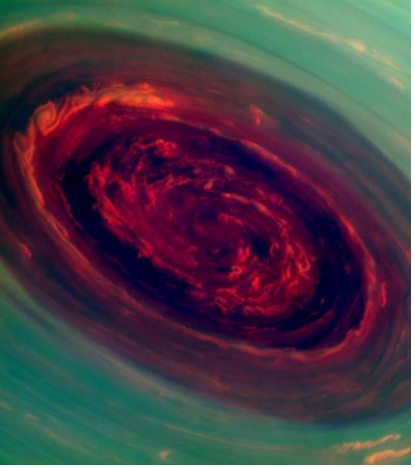
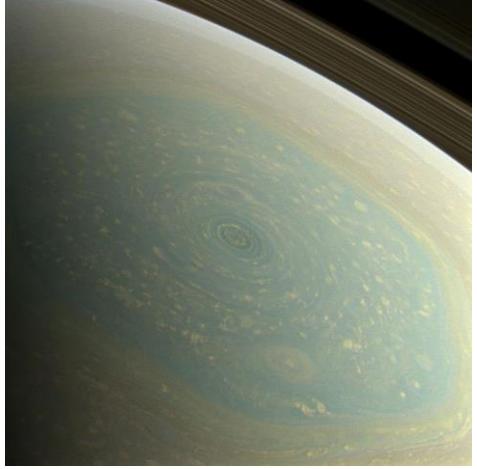
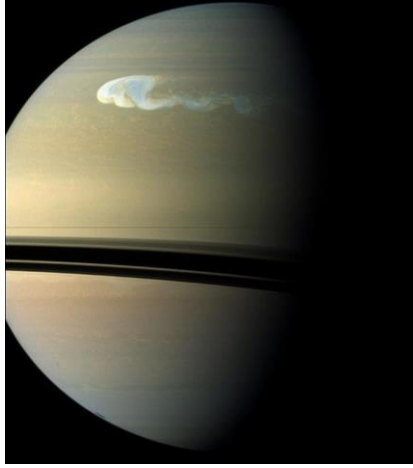


Science Planning & Sequence Team
CASSINI

SATURN TARGET WORKING TEAM

Rev 160 Segment Legacy Package

Segment Boundary: January 24, 2012 – January 29, 2012
2012-024T22:55:00 – 2012-029T22:41:00 (SCET)

Integration Began 05/16/2011
Segment Delivered to S72 Sequence 07/28/2011
Lead Integrator was Nimisha Mittal

Legacy Package Assembled by Shawn Boll

Table of Contents

*** N.A. = Slide present but content not available.**

Segment Overview and Final Products

Segment Summary

- This was a five day long periapse (4.42 Rs) segment in the first equatorial phase (EQ-1) of the Solstice Mission. It immediately followed the Saturn_159_160 CAKE (Cassini Apoapse for Kronian Exploration) segment. They were separated by a sequence boundary.

- Inbound the views of Saturn were of an increasing phase with periapse located on the mostly dark side of the planet. By segment end, the planet was nearly fully lit from Cassini's point-of-view , with ring shadows stretching across the southern hemisphere.

- Other than a brief Titan observation and an optical navigation image, the timeline was fully dedicated to Saturn science. Inbound, UVIS performed EUV/FUV scans, VIMS conducted regional mapping, ISS performed an emission angle scan, and CIRS collected a Far-IR map.

- At periapse, the time was devoted to a "Deep Atmosphere Campaign" which had VIMS and passive RADAR looking at the same region of Saturn across over three rotations of the planet (1 for RADAR centered near periapse for the sharpest RADAR imagery of ammonia vapor features, and 2 for VIMS to determine cloud motions and shapes for interpolating likely ammonia-based cloud structures to the RADAR ammonia vapor maps

- Reaction-wheel friendly secondaries were used for the waypoints, except for a slight tweak to one of them to avoid solar flight rule constraints.

Final Sequenced SPASS

GAP 1

GAP 2

Request	Riders	Start (SCET)	Start (Epoch)	Duration	End (SCET)	Primary	Secondary	Comments
Sequence S72, length = 73 days		2012-024T22:55:00		072T12:52:00	2012-097T11:47:00			
SATURN_160 Segment		2012-024T22:55:00		004T23:46:00	2012-029T22:41:00			
SP_160EA_S72IVP024_PRIME		2012-024T22:55:00		000T00:06:00	2012-024T23:01:00	XBAND to Earth	NEG_Y to 295.7/11.7	S72 IVP Gap
SP_160EA_WAYPTTURN024_PRIME	I	2012-024T23:01:00		000T00:40:00	2012-024T23:41:00	ISS_NAC to Saturn	NEG_X to 45.4/82.1	
NEW WAYPOINT		**2012-024T23:41:00**		**000T22:45:00**	**2012-025T22:26:00**	**ISS_NAC to Saturn**	**NEG_X to 45.4/82.1**	
ISS_160TI_M90R3CLD024_PRIME	C, I, V	2012-024T23:41:00	E160_M90R3CLD024+000T00:00:00	000T01:30:00	2012-025T01:11:00	ISS_NAC to Titan	NEG_X to 45.4/82.1	No Preference to secondary pointing
NAV_160SK_OPNAV251_PRIME		2012-025T01:11:00		000T01:30:00	2012-025T02:41:00	ISS_NAC to Satellites	NEG_X to 45.4/82.1	Starts at waypoint, ends at same waypoint
UVIS_160SA_EUVFUV002_PRIME	I	2012-025T02:41:00		000T16:00:00	2012-025T18:41:00	UVIS_FUV to Saturn	NEG_X to 45.4/82.1	
VIMS_160SA_REGMAP001_PRIME	I	2012-025T18:41:00		000T03:05:00	2012-025T21:46:00	ISS_NAC to Saturn	NEG_X to 45.4/82.1	
SP_160EA_DLTURN025_PRIME		2012-025T21:46:00		000T00:40:00	2012-025T22:26:00	XBAND to Earth	NEG_Y to 298.3/-4.9	
NEW WAYPOINT		**2012-025T22:26:00**		**000T11:10:00**	**2012-026T09:36:00**	**XBAND to Earth**	**NEG_Y to 298.3/-4.9**	
SP_160EA_YGAP025_PRIME		2012-025T22:26:00		000T01:30:00	2012-025T23:56:00	XBAND to Earth	NEG_Y to 298.3/-4.9	
SP_160EA_M34HEFNON025_PRIME	C	2012-025T23:56:00		000T07:45:00	2012-026T07:41:00	XBAND to Earth	NEG_Y to 298.3/-4.9	NEG_Y to Saturn (0,0,-9.5), MIMI
SP_160EA_WAYPTTURN026_PRIME		2012-026T08:56:00		000T00:40:00	2012-026T09:36:00	ISS_NAC to Saturn	NEG_X to 45.4/82.1	
NEW WAYPOINT		**2012-026T09:36:00**		**001T02:35:00**	**2012-027T12:11:00**	**ISS_NAC to Saturn**	**NEG_X to 45.4/82.1**	
ISS_160SA_EMASCAN002_PRIME	C, V	2012-026T09:36:00		000T14:55:00	2012-027T00:31:00	ISS_NAC to Saturn	NEG_X to NSP	
CIRS_160SA_FIRMAP001_PRIME		2012-027T00:31:00		000T11:00:00	2012-027T11:31:00	CIRS_FP1 to Saturn	NEG_X to 45.4/82.1	
SP_160EA_DLTURN027_PRIME		2012-027T11:31:00		000T00:40:00	2012-027T12:11:00	XBAND to Earth	NEG_Y to 300.0/-10.0	
NEW WAYPOINT		**2012-027T12:11:00**		**000T11:10:00**	**2012-027T23:21:00**	**XBAND to Earth**	**NEG_Y to 300.0/-10.0**	
SP_160EA_YGAP027_PRIME		2012-027T12:11:00		000T01:30:00	2012-027T13:41:00	XBAND to Earth	NEG_Y to 300.0/-10.0	
SP_160EA_C70METNON027_PRIME	C	2012-027T13:41:00		000T09:00:00	2012-027T22:41:00	XBAND to Earth	6_Hr_Delayed_Rolling	NEG_X to NEP or NSP, CAPS - changed to allow a safe turn
SP_160EA_WAYPTTURN027_PRIME		2012-027T22:41:00		000T00:40:00	2012-027T23:21:00	ISS_NAC to Saturn (0.0,0.0,10.0 deg. offset)	NEG_X to 45.4/82.1	
NEW WAYPOINT		**2012-027T23:21:00**		**001T13:40:00**	**2012-029T13:01:00**	**ISS_NAC to Saturn (0.0,0.0,10.0 deg. offset)**	**NEG_X to 45.4/82.1**	
VIMS_160SA_DEEPDYN001_PIE	C, M	2012-027T23:21:00		000T11:00:00	2012-028T10:21:00	ISS_NAC to Saturn	NEG_X to NSP	RBOT handoff at ISS_NAC to 4.468/-5.986 (0,0,10); NEG_X to 45.4/82.1
RADAR_160SA_GLOBALMAP002_PIE	E	2012-028T10:51:00		000T14:00:00	2012-029T00:51:00	NEG_Z to Saturn	POS_Y to NSP	RBOT pickup NAC to 4.468/-5.986, NEG_X to 45.4/82.1 with offset (0,0,10 deg); RBOT handoff NAC to 144.811/1.307, NEG_X to 45.4/82.1 with offset (0,0,10 deg)
Periapse R = 4.418 Rs, lat ...		2012-028T18:29:57		000T00:00:01	2012-028T18:29:58			
VIMS_160SA_DEEPDYN002_PIE	M	2012-029T01:21:00		000T11:00:00	2012-029T12:21:00	ISS_NAC to Saturn	NEG_X to NSP	RBOT pickup at ISS_NAC to 144.811/1.307 (0,0,10); NEG_X to 45.4/82.1
SP_160EA_DLTURN029_PRIME		2012-029T12:21:00		000T00:25:00	2012-029T12:46:00	XBAND to Earth	NEG_Y to NEP	
SP_160EA_DLTURN429_PRIME		2012-029T12:46:00		000T00:15:00	2012-029T13:01:00	XBAND to Earth	POS_X to NEP	
NEW WAYPOINT		**2012-029T13:01:00**		**000T10:20:00**	**2012-029T23:21:00**	**XBAND to Earth**	**POS_X to NEP**	
SP_160EA_YGAP029_PRIME		2012-029T13:01:00		000T00:40:00	2012-029T13:41:00	XBAND to Earth	POS_X to NEP	
SP_160EA_C70METNON029_PRIME	C	2012-029T13:41:00		000T09:00:00	2012-029T22:41:00	XBAND to Earth	POS_X to NEP	POS_X to NEP or NSP, CAPS

Final Sequenced SMT and Data Volume

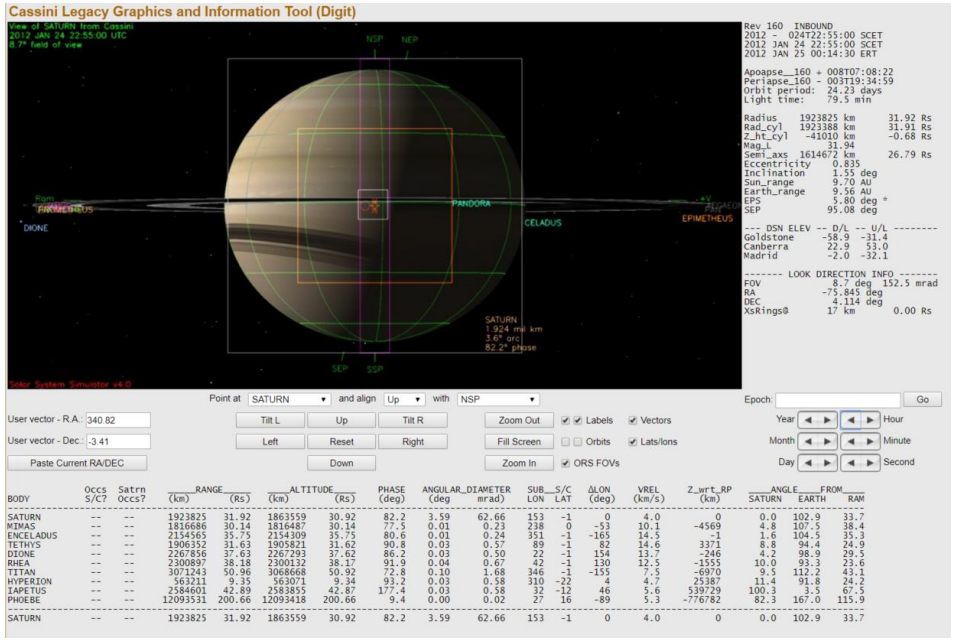
DATA VOLUME SUMMARY --- TRANSFER FRAME OVERHEAD INCLUDED (80 BITS PER 8800-BIT FRAME)

			OBSERVATION_PERIOD							DOWNLINK_PASS							
			P4						P5	RECORDED		PLAYBACK					
DOWNLINK PASS NAME	Start doy hh:mm	End doy hh:mm	START (Mb)	SCI (Mb)	HK+E (Mb)	TOTAL (Mb)	CPACTY (Mb)	MRGN (Mb)	OPNAV (Mb)	SCI (Mb)	ENGR (Mb)	TOTAL (Mb)	CPACTY (Mb)	MARGN (Mb)	NET_MARGN (Mb)	(%)	CAROVR (Mb)
SP_160EA_M34HEFNON025_PRIME	025 23:56	026 07:41	0	1070	106	1175	3322	2147	0	204	46	1425	661	-764	340	2%	764
SP_160EA_C70METNON027_PRIME	027 13:41	027 22:41	764	1438	127	2328	3322	994	0	1238	53	3619	3671	51	340	2%	0
SP_160EA_C70METNON029_PRIME	029 13:41	029 22:41	0	2868	166	3034	3322	288	0	219	53	3306	3576	270	359	2%	0

DATA VOLUME REPORT --- TRANSFER FRAME OVERHEAD NOT INCLUDED

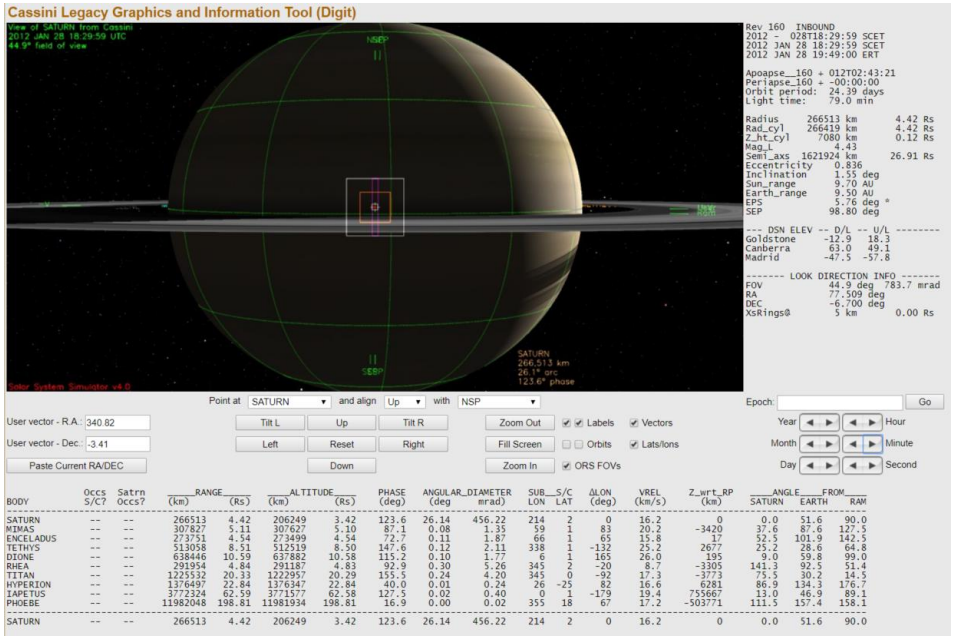
Event	Start doy hh:mm	End doy hh:mm	CAPS (Mb)	CDA (Mb)	CIRS (Mb)	INMS (Mb)	ISS (Mb)	MAG (Mb)	MIMI (Mb)	RADAR (Mb)	RPWS (Mb)	UVIS (Mb)	VIMS (Mb)	PROBE (Mb)	ENGR (Mb)	TOTAL (Mb)
OBSERVATION_NOR	024 22:55	025 23:56	63.0	47.2	136.8	13.3	52.6	89.0	76.6	0.0	118.0	259.8	160.0	0.0	104.6	1120.8
OBSERVATION_SI	024 22:55	025 23:56	0.0	0.0	0.0	0.0	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.5
SP_160EA_M34HEFNON025_PRIME	025 23:56	026 07:41	19.5	14.6	72.9	2.8	0.0	27.6	23.7	0.0	36.5	4.3	0.0	0.0	0.0	201.9
DAILY TOTAL SCIENCE	024 22:55	026 07:41	82.6	61.8	209.7	16.1	96.1	116.5	100.3	0.0	154.5	264.1	160.0	0.0	104.6	
OBSERVATION_NOR	026 07:41	027 13:41	106.7	56.6	279.3	22.8	418.5	106.7	91.8	0.0	141.5	0.7	200.0	0.0	125.4	1549.9
SP_160EA_C70METNON027_PRIME	027 13:41	027 22:41	32.4	104.1	86.4	3.2	0.0	32.0	27.5	0.0	936.3	4.9	0.0	0.0	0.0	1227.0
DAILY TOTAL SCIENCE	026 07:41	027 22:41	139.1	160.7	365.7	26.0	418.5	138.7	119.3	0.0	1077.8	5.6	200.0	0.0	125.4	
OBSERVATION_NOR	027 22:41	029 13:41	140.4	82.4	79.2	27.0	400.0	69.4	119.3	51.3	673.1	0.0	1200.0	0.0	163.0	3005.0
SP_160EA_C70METNON029_PRIME	029 13:41	029 22:41	32.4	17.0	86.4	3.2	0.0	16.0	27.5	0.0	29.2	4.9	0.0	0.0	0.0	216.7
DAILY TOTAL SCIENCE	027 22:41	029 22:41	172.8	99.4	165.6	30.2	400.0	85.4	146.9	51.3	702.2	4.9	1200.0	0.0	163.0	

Segment Geometry



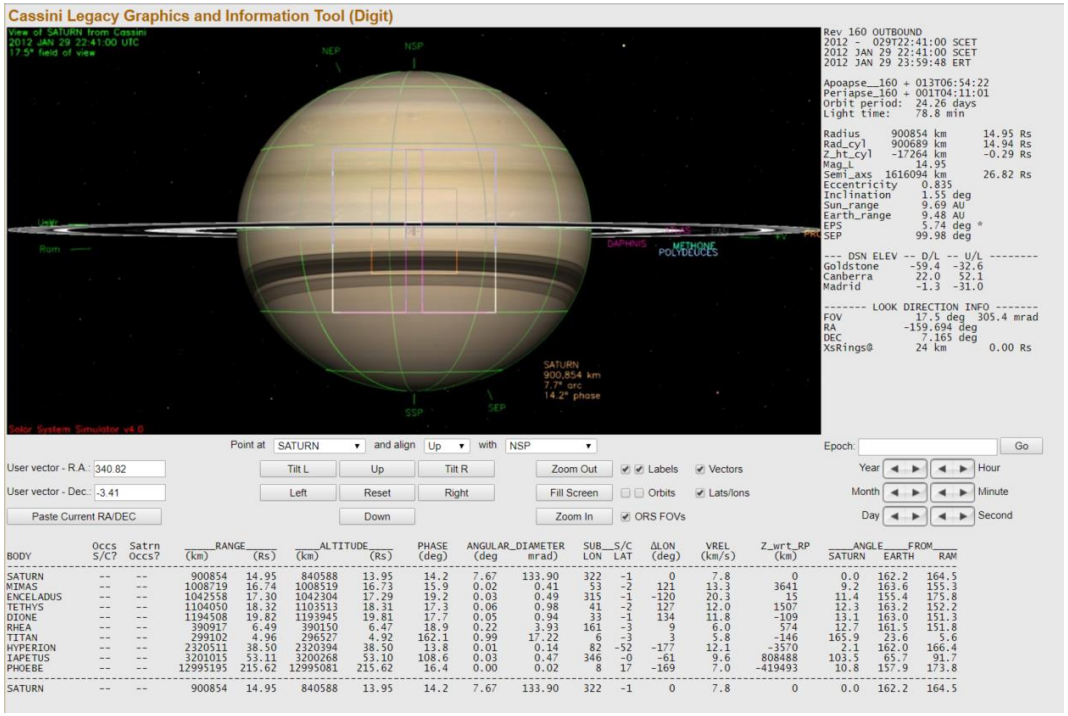
Seg Start (Left)

Periapse (below)



	Saturn Range	Phase Angle	Sub-S/C Lat.
Segment Start	31.92 Rs	82.2	-1
Periapse	4.42 Rs	123.6	2
Segment End	14.95 Rs	14.2	-1

Segment Geometry



Seg End

Solar Geometry – ORS Boresight Concerns

No ORS Boresight Solar Constraints on Science Pointing Noted.

Daily Science Highlights

January 24 (DOY 24): Saturn_160 kicked off the sequence S72 with a Titan Meteorological Campaign observation, in which ISS observed Titan to look for planet-wide cloud events observed by Earth based telescopes in the past.

January 25 (DOY 25): ISS observed the moon Hyperion for the purpose of optical navigation. This observation was followed by a UVIS EUV/FUV, which involved slow scans across Saturn's visible hemisphere to form spectral images. The VIMS REGMAP observation then concentrated on the storm in the northern hemisphere on Saturn, which had been raging since December 2010. Scientists, thinking that the String of Pearls feature (observed by VIMS periodically over five years) is hidden beneath the storm, attempted to discover if the feature was destroyed by the storm after the storm waned.

January 26 (DOY 26): The ISS EMASCAN observation performed a Saturn emission angle scan . For each latitude, images at low, medium, and high emission angles were taken as the planet rotated.

January 27 (DOY 27): The CIRS FIRMAP observation mapped the prime meridian on Saturn from the North Pole to the Equator to determine the upper troposphere and tropopause temperatures with spatial resolutions of about two degrees of latitude and longitude. One of the high priority VIMS observations kicked off at the very end of the day – the first of two observations that were to acquire a high spatial resolution map of the dynamics of Saturn's deep atmosphere.

January 28-29 (DOY 28-29): Over the next two days, the two VIMS high priority observations imaged the same low-latitude area twice, thus enabling the winds to be measured via the motions of the clouds. These observations were near periapse, allowing mapping of the motions and shapes of deep "plume" clouds as small as 300 km in width observed in the equatorial region. These observations sandwiched passive RADAR mapping that stretched over a larger region of the planet. These RADAR maps imaged ammonia vapor, revealing, in th equatorial region, the spatial variability of this condensable constituent over the same area where VIMS mapped clouds that may be formed by this ammonia vapor (either via chemical reaction of ammonia with hydrogen sulfide, H_2S, thus forming ammonia hydrosulfide (NH_4SH) clouds, or via direct condensation into ammonia clouds). Thus, together, the VIMS and RADAR maps may provide unique clues into the dynamics and meteorology of the deep atmosphere of Saturn.

Segment Integration Planning

Timeline Gaps and Suggested Observations

Gap	Start	End	Duration	Phase angle (range)	Rs range	Suggested observations/activities
1	2012-025T02:41:00	2012-025T21:46:00	19:05:00	83.1°-88.4°	30.5 – 28.5	UVIS EUV/FUV VIMS w/ ISS Riders
2	2012-026T09:36:00	2012-027T11:31:00	001T01:55:00	92.8° - 108.5°	22.9-14.9	CIRS and/or VIMS activities

Initial SMT and Data Volume

Beginning of Integration:

DATA VOLUME SUMMARY --- TRANSFER FRAME OVERHEAD INCLUDED (80 BITS PER 8800-BIT FRAME)

			OBSERVATION_PERIOD							DOWNLINK_PASS							
			P4						P5	RECORDED		PLAYBACK					
DOWNLINK PASS NAME	Start doy hh:mm	End doy hh:mm	START (Mb)	SCI (Mb)	HK+E (Mb)	TOTAL (Mb)	CPACTY (Mb)	MRGN (Mb)	OPNAV (Mb)	SCI (Mb)	ENGR (Mb)	TOTAL (Mb)	CPACTY (Mb)	MARGN (Mb)	NET_MARGN (Mb)	(%)	CAROVR (Mb)
SP_160EA_M34HEFNON025_PRIME	025 23:56	026 08:56	0	417	106	523	3322	2799	0	201	53	777	701	-77	2609	33%	76
SP_160EA_C70METNON027_PRIME	027 13:41	027 22:41	76	416	121	614	3322	2708	0	309	53	976	3671	2695	2609	36%	0
SP_160EA_C70METNON029_PRIME	029 13:41	029 22:41	0	3242	166	3408	3322	-85	0	318	53	3693	3576	-117	0	0%	117

DATA VOLUME REPORT --- TRANSFER FRAME OVERHEAD NOT INCLUDED

Event	Start doy hh:mm	End doy hh:mm	CAPS (Mb)	CDA (Mb)	CIRS (Mb)	INMS (Mb)	ISS (Mb)	MAG (Mb)	MIMI (Mb)	RADAR (Mb)	RPWS (Mb)	UVIS (Mb)	VIMS (Mb)	PROBE (Mb)	ENGR (Mb)	TOTAL (Mb)
OBSERVATION_NOR	024 22:55	025 23:56	63.0	47.2	21.6	13.3	35.0	22.2	76.6	0.0	81.0	0.0	10.0	0.0	104.6	474.5
OBSERVATION_SI	024 22:55	025 23:56	0.0	0.0	0.0	0.0	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.5
SP_160EA_M34HEFNON025_PRIME	025 23:56	026 08:56	22.7	17.0	86.4	3.2	0.0	8.0	27.5	0.0	29.2	4.9	0.0	0.0	0.0	198.9
DAILY TOTAL SCIENCE	024 22:55	026 08:56	85.7	64.2	108.0	16.6	78.5	30.2	104.1	0.0	110.2	4.9	10.0	0.0	104.6	
OBSERVATION_NOR	026 08:56	027 13:41	103.5	54.2	0.0	22.3	0.0	51.1	88.0	0.0	93.1	0.0	0.0	0.0	120.2	532.5
SP_160EA_C70METNON027_PRIME	027 13:41	027 22:41	32.4	94.0	86.4	3.2	0.0	16.0	27.5	0.0	41.4	4.9	0.0	0.0	0.0	306.0
DAILY TOTAL SCIENCE	026 08:56	027 22:41	135.9	148.3	86.4	25.6	0.0	67.1	115.5	0.0	134.6	4.9	0.0	0.0	120.2	
OBSERVATION_NOR	027 22:41	029 13:41	140.4	588.6	21.6	24.1	35.0	69.4	119.3	61.2	729.2	94.2	1330.0	0.0	163.0	3375.9
SP_160EA_C70METNON029_PRIME	029 13:41	029 22:41	32.4	102.4	86.4	3.2	0.0	16.0	27.5	0.0	42.1	4.9	0.0	0.0	0.0	315.0
DAILY TOTAL SCIENCE	027 22:41	029 22:41	172.8	690.9	108.0	27.3	35.0	85.4	146.9	61.2	771.4	99.1	1330.0	0.0	163.0	

	CAPS (Mb)	CDA (Mb)	CIRS (Mb)	INMS (Mb)	ISS (Mb)	MAG (Mb)	MIMI (Mb)	RADAR (Mb)	RPWS (Mb)	UVIS (Mb)	VIMS (Mb)	PROBE (Mb)
TOTAL RECORDED (OPNAV data not included)	394.4	903.3	302.4	69.5	113.5	182.7	366.5	61.2	1016.1	109.0	1340.0	0.0

Waypoint Selection

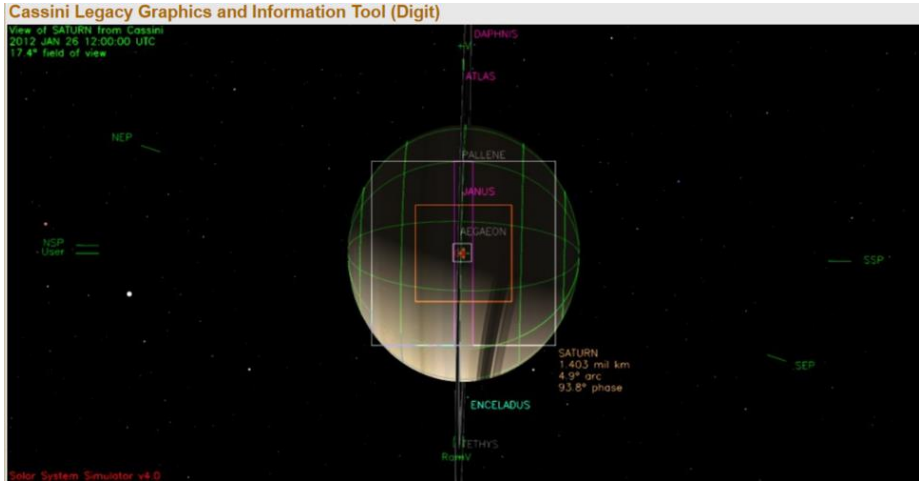
Saturn_160 RBOT friendly waypoints					
			Primary	Secondary	
Observation period	Start time	End time		NEG_X	NEG_Z
SP_160NA_OBSERV024_NA	2012-024T22:55:00	2012-025T23:56:00	Saturn	45.4/ 82.1	45.4/ 82.1
SP_160NA_OBSERV026_NA	2012-026T08:56:00	2012-027T13:41:00	Saturn	45.4/ 82.1	45.4/ 82.1
SP_160NA_OBSERV027_NA	2012-027T22:41:00	2012-029T13:41:00	Saturn	-----	-----

(Periapse)

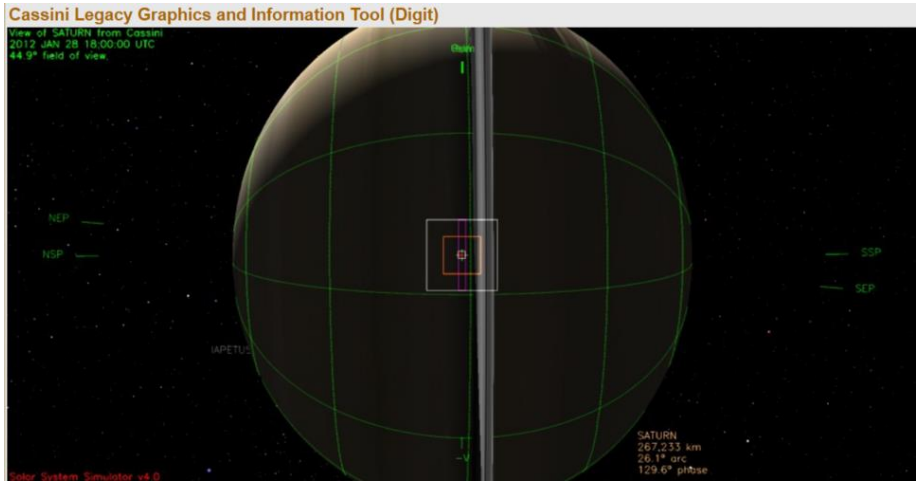
Start	End	Primary	Secondary
2012-027T22:41:00	2012-029T13:41:00	ISS_NAC to Saturn (0,0,10)	NEG X to 45.4/82.1

Waypoints Chosen

Waypoint 1 (2012-024T23:41:00 – 2012-027T23:21:00): ISS_NAC to Saturn; NEG_X to 45.4/82.1



Waypoint 2 (2012-027T23:21:00 – 2012-029T13:01:00):
ISS_NAC to Saturn (0.0,0.0,10.0 deg. offset); NEG_X to 45.4/82.1



Notes & Liens

- Pointing:
  - PERIODS WITH NO VALID WAYPOINT - None
  - Collaborative prime/rider coordination designs – None
  - >3 hr observations: <60 degrees target motion or inertial period lien added –
    - SPLAT item for RADAR_160SA_GLOBALMAP002_PIE opened.
  - CIRS heating during waypoints - None
  - Any Ybias window issues (approved deviations from guidelines) – See Y-bias page (slide 5)
  - RBOT friendliness of delivery – Used for all waypoints
- Data Volume: Nothing unusual
- DSN: No issues
- Opmodes: RADWU used for RADAR warmup and the RADAR PIE.
- Special Activities:
  - 1 Opnav at 2012-025T01:11:00

Sequence Liens:

- For concerns about the CIRS Warm Body flight rule violations due to Saturn or the Rings during downlinks, consult the Saturn TWT leads.
- The RADAR Globalmap PIE is one of the most important observations in the segment. Multiple design scenarios for this observation may be available to try out if Project Science agrees to ask AACS to entertain those during RBOT. RADAR will deliver a design containing gaps ~ every 3 hours, per RBOT guidelines, (except for the last gap which would have been very close to the end of the observation, where we have already placed a 30 min gap for potential AACS use). RADAR also plans to keep other designs with fewer gaps ready if they are allowed to submit those…assuming a clean RBOT solution for the compiled sequence during implementation.